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COMPILATION OF PILOT COGNITIVE ABILITY NORMS

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The cognitive and neuropsychological assessment of United States Air Force (USAF) pilots presents several unique problems given their relatively high cognitive functioning. The USAF currently has a procedure wherein student pilots undergo computerized cognitive assessment. The intent of this assessment is to archive premorbid data and develop clinical methods for the cognitive assessment of pilots. The current work provides the necessary background, clinical methods, and data to assess pilots who have suffered cortical insult such as trauma, disease, or exposure to toxins. Moreover, methods are delineated for those without premorbid testing. The unique contribution of the present work is, first, the very large numbers of subjects used to develop the reference norms. Second, all three major cognitive tests that have been used by the Air Force are included. Third, the tables provide conversion of all possible clinical scores. Finally, actual profile forms are provided for clinical use.

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1.0 SUMMARY

The cognitive and neuropsychological assessment of United States Air Force (USAF) pilots presents several unique problems given their relatively high cognitive functioning. The USAF currently has a procedure wherein student pilots undergo computerized cognitive assessment. The intent of this assessment is to archive premorbid data and develop clinical methods for the cognitive assessment of pilots. The current work provides the necessary background, clinical methods, and data to assess pilots who have suffered cortical insult such as trauma, disease, or exposure to toxins. Moreover, methods are delineated for those without premorbid testing. The unique contribution of the present work is, first, the very large numbers of subjects used to develop the reference norms. Second, all three major cognitive tests that have been used by the Air Force are included. Third, the tables provide conversion of all possible clinical scores. Finally, actual profile forms are provided for clinical use.

2.0 INTRODUCTION

Neuropsychology is the examination of brain-behavior relationships. Clinically, it usually takes the form of a neuropsychologist using various "tests" to map the cognitive functions of a patient (Ref 1). These tests assess intelligence, attention, memory, planning and processing, and spatial abilities, as well as other dimensions.

From a clinical perspective, Banich, Stokes, and Elledge (Ref 2) reviewed the literature on the mental status assessment of pilots. They concluded that interview methods lack sensitivity and that existing clinical tests are the alternative of choice. Specifically, they suggested using many of the classic variables found in multiscale intelligence tests. This group later demonstrated that computerized neuropsychological tests were superior to short mental status examinations when comparing a group of pilots to a group of cognitively impaired patients (Ref 3).

A more recent and very comprehensive review of aviation testing was commissioned by the U.S. Army (Ref 4). Here personality and cognitive testing is reviewed with an eye toward the selection of pilot candidates. As such, the conclusions are perhaps less applicable to the clinician and referred patient.

When assessing aviators, methodological difficulties result from the fact that this group possesses atypically high levels of cognitive ability. This situation often limits the use of certain statistics such as variance, reliability, and validity that are gleaned from much more heterogeneous samples. Aviators perform so well on tests that many assumptions that are used to detect change in patients in general are of limited value when applied to aviators.

The Medical Flight Screening (MFS) program of the United States Air Force (USAF) screens pilot candidates prior to Undergraduate Pilot Training. In addition to several medical evaluations, a number of psychological tests are administered (Ref 5). The primary purpose of the cognitive tests is to archive the individual pilot's scores for future use. The intent is to develop a registry against which future testing might be compared. As such, the psychological portion of the MFS program includes traditional measures of intelligence as well as newer computerized cognitive tasks.

2.1 Clinical Methods

There are three major ways in which to use the available data (Ref 6). The first, the Change in Performance Method, is the intended purpose of enhanced flight screening. This procedure compares the archived data (premorbid) to later testing (postmorbid), presumably after some sort of cognitive insult. The other two procedures acknowledge the fact that not all pilots will have archived premorbid data. These two procedures use data developed from those taking the MFS testing. As such, the second procedure, the Level of Performance Method, looks at the relative ability level of the new patient given the known ability levels for the tested group. The third and final method, the Pattern of Performance Method, uses a number of the tests for a new subject as control conditions for other tests taken at the same time. See Retzlaff, Callister, and King (Ref 7,8) for early applications of the three methods to the current population. The second method is presented as part of a larger cognitive factor paper by Chappelle, Ree, Barto, Teachout, and Thompson (Ref 9). The second and third methods are well presented by Thompson, Orme, and Zazeckis (Ref 10).

2.1.1 Change in Performance Method. The first method is a pretest, posttest paradigm. It is the most reliable but requires prior, premorbid testing data against which to compare later testing. In the general clinical case, a patient may have prior intelligence and neuropsychological testing, is exposed to some cortical insult, and then is re-tested. An example might be a patient in the Veteran's Administration system. It would be common for a patient to have a prior intelligence test somewhere in the system, have some sort of cortical insult such as a stroke or head injury, and then be re-tested on the same intelligence test. Here the results of the first testing can be used as a reference for the second testing. A significant decrement across testings would establish the existence of a dementia and gauge the general severity of it.

For aviators who have participated in the MFS program, premorbid data are available and can be retrieved from the USAF Aeromedical Consultation Service. Knowing the aviator's initial performance, the stability coefficient of the test, and the variability of the test for aviators, confidence bands can be established for an individual aviator. Performance below what can be expected statistically may be taken as evidence of an impairment.

2.1.2 Level of Performance Method. Methodologies are necessary for the assessment of aviators without premorbid testing. Here the MFS data may be used as a group reference. Pilots with poor performance on testing following some insult may be inferred to be at that low level of performance due to the cortical insult. Aviators who are found to be in the bottom 1% following some trauma, for example, are statistically more likely to be at that level due to the trauma than due to their initial performance. In other words, there would only be a 1% chance that the aviator was premorbidly at that low level of performance.

To effectively utilize this approach, a number of statistics and tables are necessary. First, the means and standard deviations of a large sample of fairly similar individuals are required. This provides the norm against which to compare a new individual's scores. In addition to these statistics, percentile levels of various scores are often of use. While the mean and standard deviations model the underlying distribution of test scores when the distribution is normal, they do not model skewed distributions well when there is an asymmetry in scores. Providing the scores of a distribution at critical percentile points allows the scores of new patients to be very accurately placed relative to their peers.

2.1.3 Pattern of Performance Method. While the above method uses a large group of subjects as the comparison for an individual's post-insult scores, it is also possible to use some elements of the person's own performance to make conclusions regarding cognitive change. A common approach uses the effects of aging on various types of test performance as a model. It has long been known that some types of intellectual ability are fairly sensitive to aging and other types are quite resistant to change. Classically, these are referred to as "hold" and "don't hold" variables. Scores on tasks such as vocabulary and general information generally are similar across age brackets. These tasks tend to "hold" as one ages. Scores on other tasks, such as performance type tests like speed-dependent visuomotor ability, usually drop off with age. Here, somewhere in the fifth decade of life, performances "don't hold" and begin a fairly constant decline.

Applying this method to younger patients who have had some type of cortical insult suggests that large differences in scores between "hold" and "don't hold" tests are associated with greater levels of impairment.

2.2 Purpose

The purpose of the present paper is to provide clinical procedures for the evaluation of pilots with cognitive referral questions and to provide the necessary comparative test norms. Procedures are provided for patients who do not have premorbid MFS testing. The included data and discussion focus on the Level of Performance Method of assessment. The unique contribution of the present work is, first, the very large numbers of subjects used to develop the reference norms. Second, all three major cognitive tests that have been used by the Air Force are included. Third, the tables provide conversion of all possible clinical scores. Finally, actual profile forms are provided for clinical use.

3.0 THE MULTIDIMENSIONAL APTITUDE BATTERY-II

The Multidimensional Aptitude Battery (MAB) is a broad-based test of intellectual ability. It was patterned after the Wechsler Adult Intelligence Scales (WAIS), the most widely used individually administered test of intelligence. While the WAIS is administered individually to patients, the MAB can be given to groups and requires about the same amount of total testing time.

There have been two versions. The first MAB was developed in 1984 (Ref 11). It was used quite early with USAF pilots by Retzlaff and Gibertini (Ref 12). The MAB was reviewed and restandardized in 1998 to ensure that it continued to be an effective measure of general cognitive ability. The result was the MAB-II (Ref 13). Most recently, it has shown to be useful with special operators (Ref 14).

Both these versions were adapted by the USAF for computer administration and used in the MFS program. Retzlaff, King, and Callister (Ref 15) compared a paper-and-pencil version of the MAB to the computerized version and did not find significant differences between the two tests.

The MAB has 3 summary scores and 10 subtests. The test yields a full-scale intelligence quotient (FSIQ) score, a verbal IQ (VIQ) score, and a performance IQ (PIQ) score. Verbal components are tapped by the information, comprehension, arithmetic, similarities, and

vocabulary subtests. Performance measures include the digit symbol coding, picture completion, spatial, picture arrangement, and object assembly subtests.

Scores on each of the subtests are scaled to a mean of 50 and a standard deviation (SD) of 10. Verbal and performance scores are available as is an FSIQ score, each scaled to a mean of 100 and an SD of 15. Reliabilities for the summary scores range from .94 to .98.

Previous research has demonstrated that this FSIQ score measures general cognitive ability in a multitude of age groups (Ref 16-20).

Carretta, Retzlaff, and King (Ref 21) examined the extent to which the Air Force Officer Qualifying Test (AFOQT), a cognitive test currently used by the USAF (Ref 22), and the MAB measure the same constructs. A joint factor analysis revealed that both batteries had a hierarchical structure. The higher order factor in the AFOQT has been identified previously as general cognitive ability. The correlation between the higher order factors from the two batteries was .981, demonstrating that both measure the same construct.

Table 1 presents the scale descriptions as well as the reliabilities of the subtests and IQ score composites in a sample of 91 individuals who were 20 yr old, as reported in the MAB-II manual. This age group was the most similar to our participants.

3.1 Participants

The MAB-II was administered to a sample of 25,514 pilot training candidates prior to the 53 wk of Specialized Undergraduate Pilot Training (SUPT). All were college graduates or were near completion of college. Many had private pilot's licenses or had completed part of training for a private pilot's license including flight hours in a light aircraft. Of those reporting demographic information, 91.2% were male. All participants were under the age of 40 with a mean age of 22.8 yr, SD of 2.7 yr, and modal age of 21 yr. Ethnic and racial distributions indicated that 84.2% were white, 4.0% were Hispanic, 2.4% were African American, and 9.4% were "other." All participants were tested at the School of Aerospace Medicine at Brooks City-Base, TX, or at the USAF Academy in Colorado Springs, CO.

3.2 Procedure

Descriptive data (means and SDs) were computed for the indices of the MAB-II for three groups: male, female, and the combined sample. Percentile tables were then created to show the percentile corresponding to a particular score on each MAB-II IQ score and subtest. This information is displayed for males, females, and the combined sample.

3.3 Norms

Table 2 displays the means and SDs for the IQ and subtest scores of the MAB-II for the male, female, and combined samples. The average score for "normal" subjects for the main three summary scores is 100. As can be seen, the pilots score quite a bit above this level.

Table 1. Descriptions of the MAB-II Subtests and Composites

Test	Description	Reliability
Summary Scores		
Full-Scale IQ (FSIQ)	Sum of verbal and performance scores	.98
Verbal IQ (VIQ)	Sum of all verbal subtests	.97
Performance IQ (PIQ)	Sum of all performance subtests	.98
Verbal Subtests		
Information (Info)	Degree to which an examinee has amassed a body of knowledge about many topics	.87
Comprehension (Comp)	Measures "social acculturation," "social intelligence," and the conventional principles associated with moral and ethical standards	.88
Arithmetic (Arith)	The reasoning and solution to numeric and arithmetic problems	.80
Similarities (Simil)	A measurement of likenesses and differences of objects and their properties	.90
Vocabulary (Vocab)	Identification of the meaning of words	.88
Performance Subtests		
Digit Symbol (DigSym)	Measures visual motor activity in substituting symbols for digits	.95
Picture Completion (PixComp)	Identification of pictures of common objects	.88
Spatial (Spat)	Two-dimensional visualization of abstract objects	.96
Picture Arrangement (PixArr)	Measures ability to arrange pictures in an order that creates a meaningful story	.85
Object Assembly (ObjAss)	Ability to visualize complete objects from disassembled parts	.89

Note: Reliability estimated through internal consistency using KR-20 (Ref 13).

Table 2. Means and Standard Deviations for the MAB-II Subtests

Subtest	Men (N=22,797)		Women (N=2,192)		Combined (N=25,514)	
	Mean	SD	Mean	SD	Mean	SD
FSIQ	120.75	6.61	118.85	6.49	120.59	6.63
VIQ	119.35	6.71	118.07	6.52	119.26	6.70
PIQ	119.43	8.32	117.12	8.18	119.22	8.34
Info	66.69	6.25	65.02	6.01	66.56	6.23
Comp	59.53	4.27	59.26	4.19	59.51	4.26
Arith	61.29	6.74	58.82	6.25	61.08	6.75
Simil	60.09	5.28	60.55	4.66	60.15	5.22
Vocab	59.60	7.18	59.84	7.43	59.64	7.19
DigSym	65.75	6.77	67.41	5.93	65.91	6.73
PixComp	59.86	6.35	56.69	6.30	59.56	6.41
Spat	60.20	7.00	57.71	7.30	60.48	6.55
PixArr	52.05	7.38	51.13	7.24	51.94	7.38
ObjAss	60.86	5.70	60.01	6.61	60.79	5.77

Note: Not all participants reported gender information.

Table 3 shows the percentile corresponding to a particular scaled score on the summary IQ scores of the MAB-II. These are reported for the male, female, and combined samples. By way of example, a male pilot with a scaled VIQ score of 105 would actually be in only the 3rd percentile of pilots. Interestingly, a 105 would be above average for "normal" populations.

Table 4 shows the percentile corresponding to a particular raw score on the Verbal subtests of the MAB-II: Information, Comprehension, Arithmetic, Similarities, and Vocabulary. These percentiles are reported for the male, female, and combined samples.

Table 5 shows the percentile corresponding to a particular raw score on the Performance subtests of the MAB-II: Digit Symbol, Picture Completion, Spatial Processing, Picture Arrangement, and Object Assembly. These percentiles are reported for the male, female, and combined samples.

Table 3. Percentile Equivalence for IQ Scores on the MAB-II

Score	Men			Women			Combined		
	VIQ	PIQ	FSIQ	VIQ	PIQ	FSIQ	VIQ	PIQ	FSIQ
<93	1	1	1	1	1	1	1	1	1
93	1	1	1	1	1	1	1	1	1
94	1	1	1	1	1	1	1	1	1
95	1	1	1	1	1	1	1	1	1
96	1	1	1	1	1	1	1	1	1
97	1	1	1	1	2	1	1	1	1
98	1	2	1	1	2	1	1	2	1
99	1	2	1	1	3	1	1	2	1
100	1	2	1	1	3	1	1	2	1
101	1	3	1	1	4	1	1	3	1
102	1	3	1	1	5	1	1	4	1
103	2	4	1	2	6	2	2	4	1
104	2	5	2	2	7	2	2	5	2
105	3	6	2	3	9	3	3	6	2
106	3	7	3	4	10	3	4	7	3
107	5	8	3	5	13	4	5	9	3
108	6	10	4	7	15	6	6	11	4
109	7	12	5	9	17	8	8	12	6
110	9	14	7	11	21	10	9	14	7
111	12	17	9	14	24	12	12	17	9
112	15	19	11	18	26	16	15	19	11
113	18	22	13	22	30	19	18	23	14
114	22	26	17	29	34	24	23	27	17
115	27	29	20	34	38	28	27	29	21
116	33	33	24	40	44	34	33	34	25
117	38	38	29	47	48	40	38	39	30
118	44	41	34	54	52	46	44	42	35
119	49	46	39	60	58	53	50	47	41
120	55	52	46	65	64	59	56	53	47
121	61	56	52	70	68	65	62	57	53
122	67	61	58	76	73	70	68	63	59
123	73	67	64	81	78	77	73	68	65
124	78	72	70	84	83	81	79	73	71
125	83	76	76	88	86	86	83	77	77
126	87	81	81	91	89	89	87	81	82
127	90	85	85	93	92	93	90	85	86
128	93	87	89	95	94	95	93	88	90
129	95	91	92	96	96	96	95	91	93
130	96	93	95	97	97	97	96	93	95
131	97	95	97	98	98	98	97	95	97
132	98	96	98	99	98	99	98	97	98
133	99	98	99	99	99	99	99	98	99
134	99	98	99	99	99	99	99	98	99
135	99	99	99	99	99	99	99	99	99
>135	99	99	99	99	99	99	99	99	99

Table 4. Percentile Equivalence for Verbal Subtest Scores on the MAB-II

Score	Men					Women					Combined				
	Info	Comp	Arith	Simil	Vocab	Info	Comp	Arith	Simil	Vocab	Info	Comp	Arith	Simil	Vocab
<40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
41	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
42	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
43	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
44	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
45	1	1	1	1	2	1	1	2	1	2	1	1	1	1	2
46	1	1	2	1	3	1	1	4	1	2	1	1	2	1	3
47	1	1	2	1	4	1	1	6	1	3	1	1	2	1	4
48	1	2	4	2	5	1	2	7	1	4	1	2	4	2	4
49	1	2	5	2	7	1	2	8	1	6	1	2	5	2	6
50	1	3	5	3	9	2	2	9	2	9	1	3	6	3	9
51	2	5	3	5	13	3	6	13	3	12	2	5	9	5	13
52	2	8	11	7	16	4	8	18	4	15	2	8	12	4	16
53	3	10	11	8	17	4	11	18	6	16	3	10	12	8	17
54	5	14	11	12	22	6	16	18	9	21	5	14	12	11	22
55	5	18	22	13	27	7	21	33	10	26	5	18	23	13	27
56	6	25	22	21	33	9	28	34	18	33	6	25	23	21	33
57	9	31	22	28	40	13	35	34	26	40	9	31	23	28	40
58	9	40	38	31	46	13	44	53	28	46	9	40	40	31	46
59	12	49	39	44	46	17	53	54	41	50	12	49	40	43	46
60	16	59	39	51	53	24	62	54	49	53	17	59	40	51	53
61	16	69	58	58	60	24	72	73	57	61	17	69	59	58	60
62	22	69	58	69	67	31	79	74	70	67	23	69	60	69	67
63	29	86	59	72	73	39	86	75	72	73	30	86	60	72	73
64	29	95	75	84	78	40	95	86	84	78	30	95	76	84	78
65	38	95	75	91	79	51	95	87	90	79	39	95	76	91	79
66	46	99	76	93	84	59	99	87	91	83	47	99	77	92	84
67	47	99	89	97	87	60	99	96	96	86	48	99	89	97	87
68	58	99	89	97	90	71	99	96	98	89	59	99	89	97	90
69	68	99	89	99	93	79	99	96	99	91	68	99	90	99	93
70	68	99	93	99	93	79	99	98	99	91	69	99	94	99	93
71	78	99	95	99	95	86	99	98	99	93	79	99	95	99	95
72	86	99	95	99	97	92	99	98	99	95	87	99	95	99	96
73	87	99	95	99	98	93	99	99	99	96	88	99	95	99	98
74	93	99	97	99	99	97	99	99	99	98	93	99	97	99	99
75	96	99	97	99	99	98	99	99	99	98	97	99	98	99	99
76	97	99	97	99	99	99	99	99	99	99	97	99	98	99	99
77	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
78	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
>78	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99

Table 5. Percentile Equivalence for Performance Subtest Scores on the MAB-II

Score	Men					Women					Combined				
	Dig Sym	Pix Comp	Spat	Pix Arr	Obj Ass	Dig Sym	Pix Comp	Spat	Pix Arr	Obj Ass	Dig Sym	Pix Comp	Spat	Pix Arr	Obj Ass
31	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
33	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
34	1	1	1	2	1	1	1	1	2	1	1	1	1	2	1
35	1	1	1	2	1	1	1	1	2	1	1	1	1	2	1
36	1	1	1	2	1	1	1	1	2	1	1	1	1	2	1
37	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1
38	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1
38	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1
39	1	1	1	4	1	1	1	1	4	1	1	1	1	4	1
40	1	1	1	4	1	1	1	1	5	1	1	1	1	4	1
41	1	1	1	9	1	1	1	2	11	1	1	1	1	9	1
42	1	1	1	9	1	1	2	2	11	1	1	1	1	9	1
43	1	1	1	9	1	1	3	3	11	2	1	2	1	10	1
44	1	2	2	18	1	1	4	4	21	2	1	2	2	19	1
45	1	2	2	19	2	1	5	4	22	3	1	3	2	19	2
46	1	3	2	19	2	1	7	5	22	3	1	3	3	19	2
47	1	3	3	33	3	1	7	7	37	4	1	3	3	33	3
48	1	5	4	33	3	1	12	9	37	4	1	6	5	33	3
49	2	5	5	33	4	1	12	11	38	5	2	6	6	33	4
50	2	8	6	33	4	1	17	14	38	6	2	9	7	34	4
51	3	8	8	51	7	2	18	17	56	9	3	9	9	51	7
52	4	12	10	51	7	2	24	20	56	9	4	13	11	51	7
53	6	17	13	51	10	3	33	24	57	14	6	19	14	52	11
54	7	18	16	70	10	4	34	29	75	14	6	20	17	70	11
55	9	25	20	70	16	5	44	35	76	19	9	27	22	70	16
56	10	27	25	70	16	6	46	40	77	20	10	28	26	71	16
57	14	34	30	70	24	8	56	47	83	29	13	36	32	71	24
58	15	36	37	85	24	9	57	53	89	29	15	38	38	85	25
59	20	48	43	85	36	12	69	61	89	42	19	50	45	86	36
60	20	54	50	85	44	13	69	68	89	49	19	50	52	86	44
61	27	60	56	94	51	18	79	72	95	56	26	62	58	94	52
62	27	60	62	94	51	18	84	76	96	65	26	62	63	94	52
63	35	73	67	94	70	24	88	80	96	73	34	74	68	94	70
64	35	78	72	98	76	25	91	83	98	80	34	79	73	98	77
65	44	83	76	98	83	33	94	87	98	88	43	84	77	98	84
66	44	84	81	98	87	33	94	89	98	90	43	85	82	98	87
67	55	92	85	98	95	43	97	92	98	97	54	92	86	98	95
68	55	92	88	99	98	44	97	94	99	98	54	92	89	99	98
69	68	97	91	99	98	58	99	95	99	99	67	97	92	99	98
70	68	97	93	99	99	59	99	97	99	99	67	97	94	99	99
71	83	99	96	99	99	77	99	98	99	99	82	99	97	99	99
72	83	99	99	99	99	79	99	99	99	99	83	99	99	99	99
73	87	99	99	99	99	83	99	99	99	99	86	99	99	99	99
74	98	99	99	99	99	98	99	99	99	99	98	99	99	99	99

4.0 THE MICROCOG

The MicroCog (Ref 23) is a computerized test of cognitive ability. It attempts to assess a range of cognitive behaviors such as reaction time and memory. It was primarily developed to assess clinical pathology in patients.

The test is made up of 18 subtests, which result in 52 scores. The tasks include Timers, Address, Clocks, Story 1 Immediate Recall, Math, Tic Tac 1, Analogies, Numbers Forward, Story 2 Immediate Recall, Wordlists 1 and 2, Numbers Reversed, Address Delayed Recall, Object Match, Story 1 Delayed Recall, Alphabet, Tic Tac 2, Story 2 Delayed Recall, and Timers 2.

Scores include the usual accuracy and speed/response time for most subtests. In addition, these scores are combined by multiplying them into a "proficiency" score. Further, subtests that lend themselves to additional measures such as the memory tests include variables such as false positives, response bias, and discriminability.

The subtests are combined into five "domains" that include Attention/Mental Control, Memory, Reasoning/Calculation, Spatial Processing, and Reaction Time. It is unclear from the manual how the subtests were assigned to domains. The assignment of subtests could have been based on theory and/or on factor analysis.

A number of higher order summary scores are derived. The first two, Information Processing Speed and Information Processing Accuracy, reflect a two-factor structure of the subtests. The second two purport to represent more general cognitive ability: General Cognitive Functioning is a function of the two Information Processing summary scores, and General Cognitive Proficiency is a summation of the Proficiency scores of all the subtests.

The descriptions of the MicroCog indices are displayed in Table 6 as well as the subtests making up each index.

Reliabilities range from .80 to .95. The Information Processing and General Cognitive summary scores generally correlate with the Wechsler IQ test in the .50s. The manual provides other validities for the domain scores. Here, for example, the MicroCog Memory Index correlates with the Wechsler Memory Scales in the .30s and .40s.

Chappelle, Ree, Barto, Teachout, and Thompson (Ref 9) compared the MAB and MicroCog in a structural equation model. They concluded that both tests do a good job of loading on a general intelligence factor. Of interest, the MicroCog only produced one factor during the modeling. This finding suggests that while there may be five "domains" and four more higher order summary scores, there is less specificity to the scores than a clinician may like.

4.1 Participants

The MicroCog was administered to a sample of 13,889 pilot training candidates prior to the 53 wk of SUPT. All were college graduates or were near completion of college. Many had private pilot's licenses or had completed part of training for a private pilot's license including flight hours in a light aircraft. Of those reporting demographic information, 90.8% reported that they were male. All participants were under the age of 40 with a mean age of 22.5 yr, SD of 2.7 yr, and modal age of 21 yr. Ethnic and racial distributions indicated that 83.4% were white, 4.4% were Hispanic, 2.1% were African American, and 10.1% were "other." All participants were tested at the School of Aerospace Medicine at Brooks City-Base, TX, or at the USAF Academy in Colorado Springs, CO.

4.2 Procedure

Descriptive data (means and SDs) were computed for the indices of the MicroCog for three groups: male, female, and the combined sample. Tables were then created to show the percentile corresponding to a particular score on each MicroCog scale. This information is displayed for males, females, and the combined sample.

Table 6. Descriptions of the MicroCog Indices

Index	Description	Subtests
Attention/Mental Control (Attention)	Concentration, span of attention, diligence, persistence, resistance to interference	Numbers Forward Numbers Reversed Wordlists Alphabet
Memory (Memory)	Short-term memory (storing information for a brief period) and long-term memory (storing information for a longer time period, from minutes to years)	Stories Immediate Stories Delayed Address Delayed Stories Time
Reasoning/Calculation (Reason)	Inductive reasoning, cognitive flexibility, concept formation, basic arithmetic	Analogies Object Match Math
Spatial Processing (Spatial)	Memory for novel spatial arrangements, visuo-perceptual ability	Tic Tac Clocks
Reaction Time (Reaction)	Length of psychomotor time between presented stimulus and response, readiness to respond, vigilance, attention	Timers
Information Processing Speed (Speed)	Measures the time it takes an individual to complete simple and complex mental tasks	
Information Processing Accuracy (Accuracy)	Measures the accuracy of performance with no regard given to speed	
General Cognitive Functioning (Function)	A measure of global cognitive functioning including equal weights of speed and accuracy index performance	
General Cognitive Proficiency (Proficiency)	A measure of global cognitive functioning including speed and accuracy index performance, with more weight given to accuracy.	

Note: Reliability estimated using reliability of a composite and is reported for the age group 18 to 24 (Ref 23).

4.3 Norms

Table 7 displays the descriptive statistics of the male, female, and combined samples for the indices of the MicroCog. These data were computed from the age and education corrected scaled scores. This age and education correction is important because as young, college-educated subjects, the student pilots are not being compared to a large sample of "normal" subjects. Had they been compared to a large sample of "normal" subjects, their "scores" would

have been much higher. But, since the pilots are being compared to subjects who are, for the most part, functioning at very high cognitive levels, their scaled scores appear quite average.

Table 7. Means and Standard Deviations for the MicroCog Indices

Index	Men (N=12,142)		Women (N=1,224)		Combined (N=13,889)	
	Mean	SD	Mean	SD	Mean	SD
Domains						
Attention	103.02	12.67	103.45	12.52	102.99	12.69
Memory	110.61	13.59	113.42	13.04	110.90	13.53
Reasoning	97.18	12.94	96.17	12.85	97.11	12.94
Spatial	107.37	10.43	105.32	11.17	107.01	10.57
Reaction Time	98.45	12.19	92.80	13.16	97.82	12.44
Information Processing						
Speed	105.22	12.45	105.23	11.99	105.13	12.42
Accuracy	99.08	13.30	100.06	13.30	99.16	13.33
General Cognitive						
Function	110.84	15.76	110.96	15.23	110.52	15.72
Proficiency	104.67	10.55	104.47	10.18	104.58	10.52

Note: Not all participants had gender information available.

Table 8 displays the percentile equivalence for scores on the MicroCog first-level indices: Attention/Mental Control, Reasoning/Calculation, Memory, Spatial Processing, and Reaction Time. For each index, scores and percentiles are presented for the male (M), female (F), and combined (C) samples. If a male pilot had a scaled score of 70 on Attention, he would be at only the 2nd percentile level.

Table 8. Percentile Equivalence for First-Level Indices of the MicroCog

Score	Attention			Memory			Reasoning			Spatial			Reaction Time		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C
50	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
51	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
52	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
53	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
54	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
55	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
56	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
57	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
58	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
59	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
60	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
61	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
62	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
63	1	1	1	1	1	1	1	1	1	1	1	1	1	3	2

Table 8. Percentile Equivalence for First-Level Indices of the MicroCog (continued)

Score	Attention			Memory			Reasoning			Spatial			Reaction Time		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C
64	1	1	1	1	1	1	1	2	1	1	1	1	1	3	2
65	1	1	1	1	1	1	2	2	2	1	1	1	2	3	2
66	1	1	1	1	1	1	2	2	2	1	1	1	2	4	2
67	1	1	1	1	1	1	2	2	2	1	1	1	2	4	2
68	1	1	1	1	1	1	2	2	2	1	1	1	2	5	3
69	1	2	1	1	1	1	3	3	3	1	1	1	3	6	3
70	2	2	2	1	1	1	3	4	3	1	1	1	3	7	3
71	2	2	2	1	1	1	4	4	4	1	1	1	3	7	4
72	2	2	2	1	1	1	4	5	4	1	1	1	4	8	4
73	2	2	2	1	1	1	5	5	5	1	2	1	4	8	4
74	3	3	3	1	1	1	5	6	5	1	2	1	4	9	5
75	3	3	3	1	1	1	6	6	6	2	3	2	5	10	6
76	3	3	3	1	1	1	7	8	7	2	3	2	5	11	6
77	4	3	4	2	1	1	7	9	8	2	3	2	6	12	7
78	4	4	4	2	1	2	9	11	9	2	4	2	7	14	8
79	5	5	5	2	1	2	9	12	10	2	4	3	8	16	9
80	5	5	6	2	1	2	11	12	11	3	4	3	8	17	9
81	6	6	6	3	2	3	12	13	12	3	5	3	9	18	10
82	6	6	6	4	2	3	14	16	14	3	5	4	11	21	12
83	8	7	8	4	2	4	15	17	15	4	7	4	11	22	12
84	8	7	8	4	3	4	17	19	17	5	7	5	12	24	14
85	9	9	9	5	3	5	17	19	17	5	7	5	14	27	16
86	9	9	9	5	3	5	20	22	20	6	9	6	14	27	16
87	11	11	11	6	4	6	23	26	23	6	9	6	17	30	18
88	12	11	12	7	5	7	24	26	24	7	10	7	19	35	21
89	13	13	13	8	5	7	27	29	27	7	10	7	19	35	21
90	14	13	14	9	6	8	28	30	28	8	11	9	22	39	24
91	16	15	16	10	7	9	32	34	32	8	11	9	25	43	27
92	19	19	20	10	7	10	32	36	32	9	13	10	25	43	27
93	21	20	21	12	9	11	37	39	37	10	13	11	29	48	31
94	23	22	23	13	10	12	38	40	38	11	16	12	33	52	35
95	24	22	24	13	10	13	42	45	42	13	17	14	34	53	36
96	28	25	28	15	11	15	47	51	47	14	19	15	38	58	40
97	29	26	28	18	13	17	48	52	48	16	20	16	41	62	44
98	32	29	32	19	14	18	52	56	52	17	21	18	42	62	44
99	34	30	33	20	15	19	53	57	53	19	23	20	47	66	49
100	39	36	39	22	17	22	59	64	59	21	25	22	52	70	54
101	40	36	40	25	19	25	60	65	60	23	28	24	57	75	59
102	44	41	44	25	19	25	64	68	64	26	31	27	58	75	60
103	46	43	46	28	22	27	65	68	65	29	36	30	62	79	64
104	52	49	52	31	24	31	70	74	70	32	40	33	67	82	69
105	54	50	53	33	25	32	74	78	74	35	43	36	69	83	70

Table 8. Percentile Equivalence for First-Level Indices of the MicroCog (concluded)

Score	Attention			Memory			Reasoning			Spatial			Reaction Time		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C
106	60	57	60	35	28	34	75	78	75	38	47	39	74	87	76
107	60	61	60	39	32	38	80	83	80	39	48	41	79	89	80
108	66	64	66	39	32	39	82	84	82	46	55	47	80	90	81
109	71	70	72	42	35	42	84	85	84	48	56	49	83	92	84
110	72	71	72	46	38	46	85	86	85	55	65	57	87	93	88
111	77	76	77	47	39	47	88	89	88	58	66	59	88	94	89
112	78	78	78	52	43	51	88	89	88	66	74	68	91	96	92
113	83	82	83	55	47	54	91	92	91	69	75	70	94	98	94
114	83	83	83	56	47	55	93	94	93	76	81	77	94	98	95
115	87	87	87	61	51	60	93	94	93	78	82	79	96	98	96
116	87	87	87	65	55	64	95	96	95	84	88	85	97	98	97
117	90	91	90	65	58	64	95	97	95	89	94	90	97	99	97
118	90	92	91	69	60	68	97	98	97	91	95	92	98	99	98
119	93	93	93	73	64	72	97	98	97	95	97	95	99	99	99
120	93	94	93	73	65	73	98	99	98	96	98	96	99	99	99
121	95	95	95	77	69	76	98	99	98	98	99	98	99	99	99
122	95	95	95	81	74	80	99	99	99	98	99	98	99	99	99
123	96	97	97	81	74	81	99	99	99	99	99	99	99	99	99
124	97	98	98	84	79	84	99	99	99	99	99	99	99	99	99
125	98	99	98	88	84	87	99	99	99	99	99	99	99	99	99
126	98	99	98	88	84	88	99	99	99	99	99	99	99	99	99
127	99	99	99	91	87	91	99	99	99	99	99	99	99	99	99
128	99	99	99	93	90	93	99	99	99	99	99	99	99	99	99
129	99	99	99	93	91	93	99	99	99	99	99	99	99	99	99
130	99	99	99	95	94	95	99	99	99	99	99	99	99	99	99
131	99	99	99	97	95	97	99	99	99	99	99	99	99	99	99
132	99	99	99	98	96	97	99	99	99	99	99	99	99	99	99
133	99	99	99	99	97	98	99	99	99	99	99	99	99	99	99
134	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
135	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
136	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99

Table 9 displays the percentile equivalence for scores on the MicroCog second-level indices: Information Processing Speed and Information Processing Accuracy. For each index, scores and percentiles are presented for the male (M), female (F), and combined (C) samples.

Table 10 displays the percentile equivalence for scores on the MicroCog third-level indices: General Cognitive Functioning and General Cognitive Processing. For each index, scores and percentiles are presented for the male (M), female (F), and combined (C) samples.

Table 9. Percentile Equivalence for Information Processing Indices of the MicroCog

Score	Speed			Accuracy		
	M	F	C	M	F	C
55	1	1	1	1	1	1
56	1	1	1	1	1	1
57	1	1	1	1	1	1
58	1	1	1	1	1	1
59	1	1	1	1	1	1
60	1	1	1	1	1	1
61	1	1	1	1	1	1
62	1	1	1	1	1	1
63	1	1	1	1	2	1
64	1	1	1	1	2	1
65	1	1	1	1	2	1
66	1	1	1	2	2	2
67	1	1	1	2	2	2
68	1	1	1	2	3	2
69	1	1	1	3	3	3
70	1	1	1	3	3	3
71	1	1	1	3	3	3
72	1	1	1	4	3	4
73	2	1	2	4	4	4
74	2	1	2	4	4	4
75	2	1	2	5	5	5
76	2	2	2	6	5	6
77	3	2	3	6	6	6
78	3	2	3	7	7	7
79	4	3	4	8	7	8
80	4	3	4	9	8	9
81	5	3	5	10	9	10
82	5	4	5	11	10	11
83	6	5	6	12	11	12
84	7	6	7	14	13	14
85	7	7	7	16	14	16
86	8	8	8	17	15	17
87	9	8	9	19	16	18
88	10	10	10	21	18	21
89	11	11	12	23	19	22
90	12	12	12	25	21	24
91	14	12	14	27	22	27
92	15	14	15	29	25	29
93	17	16	17	31	27	31
94	19	18	19	34	30	33
95	20	19	20	37	33	36
96	22	21	23	39	35	39
97	24	23	24	42	36	41
98	27	26	27	45	40	45
99	30	29	30	48	44	48
100	32	31	32	51	47	50
101	34	34	34	54	51	53
102	38	39	38	58	54	57
103	40	41	41	60	57	60
104	43	44	43	63	60	63
105	45	47	46	66	63	66
106	48	49	49	69	66	69
107	53	54	54	72	70	72
108	56	57	56	75	73	75
109	59	60	60	78	75	77
110	62	62	62	80	78	80
111	65	66	66	82	80	82
112	70	71	71	85	82	85
113	73	75	73	87	84	87
114	76	78	76	88	87	88
115	78	80	79	90	88	90
116	81	82	81	93	92	93
117	85	87	86	94	94	94
118	87	88	87	95	95	95
119	89	90	90	96	96	96
120	91	92	91	97	97	97
121	93	93	93	97	98	97
122	95	95	95	98	98	98
123	96	97	96	98	99	98
124	97	98	97	99	99	99
125	98	98	98	99	99	99
126	98	98	98	99	99	99
127	99	99	99	99	99	99
128	99	99	99	99	99	99

Table 10. Percentile Equivalence for General Cognitive Indices of the MicroCog

Score	Functioning			Processing		
	M	F	C	M	F	C
68	1	1	1	1	1	1
69	1	1	1	1	1	1
70	1	1	1	1	1	1
71	1	1	1	1	1	1
72	1	1	1	1	1	1
73	1	1	1	1	1	1
74	1	1	1	1	1	1
75	1	1	2	1	1	1
76	2	2	2	1	1	1
77	2	2	2	1	1	1
78	2	2	2	1	1	1
79	2	2	3	1	1	1
80	3	3	3	1	1	1
81	3	3	3	2	2	2
82	4	4	4	2	2	2
83	4	4	4	2	2	2
84	5	4	5	3	3	3
85	5	5	6	4	4	4
86	6	6	6	5	5	5
87	7	7	7	5	6	6
88	8	7	8	6	6	6
89	9	8	9	7	7	7
90	10	8	10	9	7	9
91	11	9	11	11	10	11
92	12	11	12	12	12	12
93	13	11	14	14	14	14
94	15	13	16	16	16	16
95	16	14	17	18	19	19
96	19	17	19	21	21	21
97	20	19	21	25	26	26
98	22	20	22	28	28	28
99	24	23	25	31	31	31
100	26	25	26	34	34	34
101	28	28	29	37	37	38
102	30	29	31	40	40	40
103	32	31	32	46	46	46
104	35	34	36	49	49	50
105	36	36	37	53	54	54
106	40	39	41	56	57	57
107	42	42	43	60	62	61
108	45	45	46	63	65	64
109	47	47	48	69	70	69
110	49	50	50	72	74	72
111	52	53	53	75	76	75
112	54	54	55	77	78	77
113	57	58	58	80	81	80
114	59	60	60	82	83	82
115	61	62	62	86	88	86
116	63	64	64	87	90	88
117	65	66	66	89	91	90
118	68	70	69	91	92	91
119	70	71	71	92	93	92
120	73	73	73	93	94	93
121	74	75	75	95	96	95
122	75	76	76	96	96	96
123	78	78	78	97	97	97
124	79	80	80	97	97	97
125	82	83	82	98	98	98
126	83	84	83	98	98	98
127	85	86	85	99	99	99
128	86	87	86	99	99	99
129	87	88	87	99	99	99
130	89	90	89	99	99	99
131	90	90	90	99	99	99
132	92	92	92	99	99	99
133	92	92	93	99	99	99
134	93	93	93	99	99	99
135	94	95	95	99	99	99
136	95	95	95	99	99	99
137	96	96	96	99	99	99
138	96	96	96	99	99	99
139	97	97	97	99	99	99
140	98	98	98	99	99	99
141	98	98	98	99	99	99
142	98	98	99	99	99	99
143	99	99	99	99	99	99
144	99	99	99	99	99	99
145	99	99	99	99	99	99
146	99	99	99	99	99	99

5.0 THE COGSCREEN-AEROMEDICAL EDITION

The CogScreen-Aeromedical Edition (AE) (Ref 24) is a test of cognitive ability intended for use in the assessment of pilots. While the MAB is a test of relatively complex, higher order intellectual processes, the CogScreen tasks are generally more fundamental processes such as reaction time. It is not a test of aviation knowledge but includes abilities necessary in the performance of aviation duties. It was supported by the Federal Aviation Administration as a measure of the underlying abilities related to flying. The development and normative sample consists of 584 commercial aviators.

There are 11 tasks, which result in 65 scores. The tasks include Backward Digit Span (BDS), Math (MATH), Visual Sequence Comparison (VSC), Symbol Digit Coding (SDC), Matching-to-Sample (MTS), Manikin (MAN), Divided Attention (DAT), Auditory Sequence Comparison (ASC), Pathfinder (PF), Shifting Attention (SAT), and Dual Task (DTT). Each of the tasks is usually scored in a number of ways. Typical scorings include task speed, accuracy, and throughput. Throughput is a function of speed and accuracy – basically the number of correct responses per minute. It is indicative of the amount of work accomplished. A number of tasks also include process completion measures, which quantify task specific behavior such as control of the computer screen elements.

The manual and other research refers to the CogScreen scores by a relatively cryptic variable naming process. These variable names are concatenations of the task acronym (e.g., MTS for Matching-to-Sample) and the type of data (e.g., RTC for reaction time). As such, Matching-to-Sample Speed is referred to by the variable name MTSRTC.

Table 11 provides descriptions of the CogScreen subtests. Each subtest returns a score representing the individual's response speed, accuracy, and throughput. For some subtests, process measures are also generated. Response speed is measured by the median reaction time to correctly respond to a task. Response accuracy is the percentage of responses that are correct out of the total number of items administered. Throughput measures are derived scores and reflect efficiency of responses and the number of correct responses per minute. Finally, process measures provide information about qualitative, error, and other process-oriented measures not falling in the other three categories of scores (Ref 24).

Stability of the CogScreen was reported to have been calculated using the Spearman-Brown prediction formula based on 199 airline pilots retested at 6 and 12 mo after initial test administration (Ref 24). Throughput variables were selected for reliability estimation because they have normal distributions and are a combination of speed and accuracy measures. Test-retest reliability coefficients for throughput measures ranged from .69 to .90, with an average coefficient of .80. For the speed scores, reliability coefficients ranged from .63 to .91, with an average coefficient of .80. Due to low variability in pilot scores, several tracking subtests were removed prior to calculating the average reliability for speed measures. Reliability was not calculated for accuracy and process variables because of the low variability in scores (Ref 24).

Table 11. Description of the CogScreen Subtests

Subtest	Definition
Backward Digit Span	Recall a series of three to six digits in reverse order.
Math	Calculate multistep word problems.
Visual Sequence Comparison	Determine whether two alphanumeric strings presented side-by-side are the same or different.
Symbol Digit Coding	Recall (immediate and delayed) the six symbol-digit pairs presented in the first part of the test.
Matching-to-Sample	After viewing a four-by-four grid pattern, select the correct pattern from two grids displayed side by side.
Manikin	Determine which hand a figure is holding a flag in by mentally rotating the image in one of four positions.
Divided Attention Test	Monitor the vertical movement of a cursor within a circle and return it to center when it exceeds the boundaries. The task is performed alone and with the Visual Sequence Comparison task.
Auditory Sequence Comparison	Compare two series of four to eight tones of varying pitch presented sequentially.
Pathfinder	Determine which character comes next in a series after being presented with three sequencing rules of the characters (numbers, letters, or both).
Shifting Attention	Determine the sequence of letters and numbers based upon changing rules.
Dual Task	Perform a tracking test and a delayed recall memory task separately, then at the same time.

5.1 Participants

The CogScreen-AE was administered to a sample of 10,314 pilot training candidates prior to the 53 wk of SUPT. All were college graduates or were near completion of college. Many had private pilot's licenses or had completed part of training for a private pilot's license including flight hours in a light aircraft. Of those reporting demographic information, 91.7% were men. All participants were under the age of 35 with a mean age of 23.22 yr, SD of 2.6 yr, and modal age of 21 yr. Ethnic and racial distributions indicated that 88.4% were white, 3.6% were Hispanic, 2.5% were African American, and 5.5% were "other." All participants were tested at the School of Aerospace Medicine at Brooks City-Base, TX, or at the USAF Academy in Colorado Springs, CO.

5.2 Procedure

Descriptive data (means and SDs) were computed for the subtests of the CogScreen for three groups: male, female, and the combined sample. Percentile tables were then created to show the percentile corresponding to a particular raw score on each CogScreen subtest. This information is displayed for males, females, and the combined sample.

5.3 Norms

Table 12 displays the descriptive statistics of the male, female, and combined samples for speed subtests of the CogScreen. Quite a bit of variation is seen across the tasks. Some are very short latencies with means in the .50-s range. Others, such as MATH at 25 s, seem to be much more than simple reaction time.

Retzlaff, Callister, and King (Ref 7) suggest that the speed measures with the highest interpretability are Manikin (MANRTC) and Matching-to-Sample (MTSRTC), since these are more focused measures of speed with room for variations in performance. The current data bear this out.

Table 13 displays the descriptive statistics of the male, female, and combined samples for accuracy subtests of the CogScreen. Note that the Shifting Attention Discovery Accuracy (SATDIACC) and the Symbol Digit Coding Delayed Recall Accuracy (SDCDRACC) variables are missing for our sample. This could be due to problems with transitioning data collected using an outdated method to a new database.

For the normative sample and the current pilot sample, the accuracy variables produce a "ceiling effect," since the tasks are so simple that most pilots will score above 90%. As such, these scales will be of limited value for the researcher and clinician.

Table 14 displays the descriptive statistics of the male, female, and combined samples for the throughput subtests of the CogScreen. Throughput variables are a product of accuracy and speed variables.

Table 15 displays the descriptive statistics of the male, female, and combined samples for the process subtests of the CogScreen.

Tables 16 through 19 display the raw scores corresponding to the deciles for the speed, accuracy, throughput, and process measures of the CogScreen male sample. Looking at Table 16, for example, a pilot who takes 35 s to complete the MATH subtest would be in the bottom 10% of this sample.

Tables 20 through 23 display the raw scores corresponding to the deciles for the speed, accuracy, throughput, and process measures of the CogScreen female sample.

Tables 24 through 27 display the raw scores corresponding to the deciles for the speed, accuracy, throughput, and process measures of the CogScreen combined sample.

Table 12. Means and Standard Deviations for the CogScreen Speed Variables

Variable	Males (N=9,460)		Females (N=854)		Combined (N=10,314)	
	Mean	SD	Mean	SD	Mean	SD
ASCRTC	.67	.19	.65	.18	.67	.19
DATDRTC	.57	.22	.62	.23	.57	.22
DATIRTC	.34	.13	.36	.09	.34	.13
DATSCRTC	2.07	.59	2.03	.61	2.07	.60
DTTAABS	11.67	11.53	17.42	15.54	12.14	12.01
DTTDABS	36.23	25.32	53.63	27.13	37.67	25.92
DTTPARTC	.41	.16	.40	.15	.41	.16
DTTPDRTC	.50	.19	.55	.21	.50	.19
MANRTC	1.69	.39	1.71	.40	1.69	.39
MTSRTC	1.19	.27	1.19	.25	1.20	.27
PFCRTC	1.03	.28	.94	.23	1.02	.28
PFLRTC	.71	.15	.69	.17	.71	.15
PFNRTC	.76	.59	.74	.24	.76	.57
MATHRTC	24.11	7.50	25.04	7.22	24.18	7.48
SATACRTC	.61	.11	.60	.10	.61	.11
SATADRTC	.56	.11	.54	.10	.56	.11
SATDIRTC	.80	.21	.79	.20	.80	.21
SATINRTC	.70	.14	.69	.13	.70	.14
VSCRTC	2.01	.45	1.90	.43	2.00	.45

Table 13. Means and Standard Deviations for the CogScreen Accuracy Variables

Variable	Males		Females		Combined	
	Mean	SD	Mean	SD	Mean	SD
PFCACC	97.99	4.21	98.07	3.25	98.00	4.13
PFLACC	99.38	2.90	99.35	2.19	99.38	2.84
PFNACC	99.56	3.09	99.38	3.04	99.55	3.09
DATSCACC	93.46	8.44	93.93	8.35	93.50	8.43
DTTPAACC	94.96	6.67	95.34	6.44	94.99	6.66
DTTPDACC	89.34	15.30	86.36	17.74	89.09	15.53
ASCACC	93.13	8.86	93.57	7.86	93.17	8.78
BDSACC	89.85	15.43	86.67	16.51	86.89	15.52
MANACC	93.96	10.17	93.58	10.70	93.93	10.21
MTSACC	95.32	6.34	95.28	6.51	95.32	6.36
MATHACC	84.01	18.45	82.04	19.05	83.85	18.51
SATACACC	98.83	5.65	98.82	4.82	98.83	5.59
SATADACC	98.65	5.59	98.96	4.72	98.68	5.53
SATINACC	97.42	5.49	97.59	4.60	97.43	5.42
VSCACC	98.33	3.62	98.57	2.76	98.35	3.56
SDCACC	99.11	7.79	99.18	6.95	99.12	7.73
SDCIRACC	77.67	37.97	76.92	39.95	77.61	38.14

Note: There were no data available for SATDIACC or SDCDRACC

Table 14. Means and Standard Deviations for the CogScreen Throughput Variables

Variable	Males		Females		Combined	
	Mean	SD	Mean	SD	Mean	SD
DATSCPUT	28.92	7.35	29.71	7.52	28.99	7.37
DTTPAPUT	169.75	202.20	180.79	279.32	170.66	209.67
DTTPDPUT	130.89	166.71	108.80	56.07	129.06	160.59
ASCPUT	88.96	25.00	92.33	25.40	89.24	25.05
MANPUT	35.25	9.04	34.74	9.10	35.21	9.05
MTSPUT	50.26	10.81	49.96	9.96	50.24	10.74
SDCPUT	83.11	20.95	88.23	20.12	83.54	20.93
MATHPUT	2.32	.98	2.18	1.33	2.31	1.01
SATACPUT	100.04	17.06	101.99	17.13	100.20	17.08
SATADPUT	109.75	20.68	112.42	20.02	109.97	20.63
SATDIPUT	54.44	17.43	55.40	15.51	54.52	17.28
SATINPUT	86.87	25.70	88.08	16.67	86.97	25.08
VSCPUT	30.70	6.76	32.70	7.06	30.86	6.81
PFCPUT	61.23	15.97	66.86	16.49	61.70	16.09
PFLPUT	87.85	18.24	90.95	18.54	88.10	18.28
PFNPUT	83.04	18.70	85.30	18.90	83.23	18.73

Table 15. Means and Standard Deviations for the CogScreen Process Variables

Variable	Males		Females		Combined	
	Mean	SD	Mean	SD	Mean	SD
PFCCOOR	2.43	6.50	1.81	4.92	2.37	6.39
PFLCOOR	2.48	6.39	1.89	4.98	2.43	6.29
PFNCOOR	2.53	9.57	1.76	5.12	2.47	9.29
DATDPRE	2.26	1.68	2.28	1.57	2.26	1.67
DATIPRE	5.51	3.20	4.95	2.89	5.46	3.18
DTTAHIT	.94	1.37	1.65	2.07	1.01	1.47
DTTDHIT	1.74	2.44	3.12	3.12	1.89	2.56
SATDIFAI	2.32	1.83	2.30	1.81	2.32	1.83
SATDIPER	2.16	2.18	2.15	2.09	2.16	2.17
SATDIRUL	7.21	2.31	7.26	2.25	7.21	2.31

Table 16. Male Percentile Equivalence Scores for CogScreen Speed Variables

Variable	90%	80%	70%	60%	50%	40%	30%	20%	10%
ASCRTC	.47	.52	.56	.60	.64	.68	.74	.80	.91
DATDRTC	.37	.42	.46	.50	.54	.58	.63	.70	.80
DATIRTC	.26	.28	.30	.31	.33	.34	.36	.39	.44
DATSCRTC	1.48	1.60	1.71	1.81	1.92	2.05	2.23	2.48	2.88
DTTAABS	2.63	3.36	4.14	5.12	6.67	9.28	13.52	19.33	28.31
DTTDABS	9.89	13.06	16.70	21.54	28.19	37.83	48.53	60.42	75.73
DTTPARTC	.26	.29	.31	.34	.37	.41	.46	.52	.62
DTTPDRTC	.30	.35	.39	.43	.47	.51	.56	.62	.73
MANRTC	1.24	1.36	1.45	1.54	1.64	1.73	1.85	2.00	2.21
MATHRTC	15.53	17.75	19.52	21.27	22.98	24.91	27.12	29.97	34.49
MTSRTC	.90	.98	1.04	1.10	1.15	1.21	1.28	1.37	1.51
PFCMRT	.72	.80	.86	.92	.98	1.05	1.13	1.23	1.39
PFLMRT	.53	.58	.62	.66	.69	.73	.77	.82	.90
PFNMRT	.56	.61	.65	.69	.73	.78	.83	.89	.98
SATACRTC	.49	.52	.55	.57	.60	.62	.65	.68	.74
SATADRTC	.44	.47	.49	.52	.54	.57	.60	.64	.70
SATDIRTC	.60	.65	.69	.73	.76	.80	.85	.92	1.03
SATINRTC	.54	.59	.62	.65	.68	.72	.75	.80	.87
VSCRTC	1.49	1.64	1.75	1.86	1.96	2.07	2.20	2.36	2.61

Table 17. Male Percentile Equivalence Scores for CogScreen Accuracy Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
ASCACC	.80	.89	.90	.90	.90	1.00	1.00	1.00	1.00
BDSACC	.62	.75	.87	.87	.87	1.00	1.00	1.00	1.00
DATSCACC	.82	.88	.92	.93	.94	1.00	1.00	1.00	1.00
DTTPAACC	.88	.92	.94	.95	.97	.98	1.00	1.00	1.00
DTTPDACC	.80	.86	.89	.91	.93	.94	.96	.97	1.00
MANACC	.85	.90	.94	.95	1.00	1.00	1.00	1.00	1.00
MATHACC	.90	.90	.95	.95	.95	1.00	1.00	1.00	1.00
MTSACC	.90	.90	.95	.95	.95	1.00	1.00	1.00	1.00
PFCACC	.92	.96	.96	1.00	1.00	1.00	1.00	1.00	1.00
PFLACC	.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PFNACC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATACACC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATADACC	.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATINACC	.94	.96	.97	.97	1.00	1.00	1.00	1.00	1.00
SDCACC	.98	.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SDCIRACC	.00	.50	.83	1.00	1.00	1.00	1.00	1.00	1.00
VSCACC	.95	.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 18. Male Percentile Equivalence Scores for CogScreen Throughput Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
ASCPUT	59.00	68.00	75.00	81.00	87.00	93.00	100.70	109.00	120.00
DATSCPUT	19.00	22.10	25.00	27.00	29.00	31.00	33.00	35.00	38.00
DTTPAPUT	90.90	108.00	123.00	138.00	153.84	169.00	183.00	201.00	227.00
DTTPDPUT	66.00	83.00	95.08	106.00	117.00	128.00	141.00	159.00	188.00
MANPUT	24.00	27.00	30.00	33.00	35.00	37.00	40.00	43.00	47.00
MATHPUT	1.20	1.50	1.80	2.00	2.20	2.40	2.70	3.10	3.60
MTSPUT	38.00	42.00	45.00	47.00	50.00	52.00	55.00	59.00	64.00
PFCPUT	42.00	48.00	52.00	56.00	60.00	64.00	69.00	74.00	82.00
PFLPUT	66.00	72.28	77.92	82.00	86.00	91.00	96.00	102.00	112.00
PFNPUT	61.00	67.00	72.28	77.00	81.85	86.00	92.00	98.00	107.00
SATACPUT	80.00	86.95	91.00	96.00	100.00	104.00	108.00	114.00	122.00
SATADPUT	84.00	92.30	98.00	104.00	109.09	115.00	121.00	127.00	136.00
SATDIPUT	32.01	42.00	47.87	52.00	55.00	59.00	63.00	67.00	74.00
SATINPUT	66.20	73.00	77.00	82.00	85.47	90.00	95.00	101.00	109.00
SDCPUT	61.74	70.56	76.00	81.00	84.00	88.00	91.13	97.00	106.91
VSCPUT	23.00	25.00	27.00	28.63	30.00	32.00	34.00	36.00	40.00

Table 19. Male Percentile Equivalence Scores for CogScreen Process Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
DATDPRE	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	4.00
DATIPRE	2.00	3.00	4.00	4.00	5.00	6.00	7.00	8.00	10.00
DTTAHIT	0.00	0.00	0.00	0.00	1.00	1.00	1.00	2.00	2.00
DTTDHIT	0.00	0.00	0.00	0.00	1.00	1.00	2.00	3.00	5.00
PFCCOOR	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.20	1.50
PFLCOOR	0.50	0.70	0.80	0.80	0.90	1.00	1.10	1.30	1.70
PFNCOOR	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.50
SATDIFAI	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	5.00
SATDINON	0.00	0.00	1.00	1.00	1.00	2.00	2.00	3.00	5.00
SATDIPER	0.00	1.00	1.00	1.00	2.00	2.00	3.00	3.00	5.00
SATDIRUL	4.00	6.00	7.00	8.00	8.00	8.00	9.00	9.00	9.00

Table 20. Female Percentile Equivalence Scores for CogScreen Speed Variables

Variable	90%	80%	70%	60%	50%	40%	30%	20%	10%
ASCRTC	.46	.51	.55	.58	.63	.66	.71	.78	.88
DATDRTC	.40	.45	.50	.54	.58	.62	.68	.75	.86
DATIRTC	.27	.30	.31	.33	.34	.36	.38	.41	.48
DATSCRTC	1.45	1.55	1.65	1.76	1.87	1.99	2.16	2.44	2.87
DTTAABS	3.61	4.81	6.40	8.50	12.27	15.95	21.36	29.77	39.02
DTTDABS	17.03	25.46	35.28	44.91	52.95	62.96	71.46	79.98	90.02
DTTPARTC	.26	.29	.31	.34	.36	.39	.43	.48	.57
DTTPDRTC	.34	.39	.44	.48	.52	.56	.60	.68	.80
MANRTC	1.24	1.37	1.48	1.57	1.65	1.74	1.88	2.01	2.23
MATHRTC	16.61	18.79	20.76	22.52	23.98	25.98	28.11	30.92	34.41
MTSRTC	.93	1.00	1.05	1.10	1.15	1.21	1.27	1.35	1.50
PFCMRT	.67	.74	.79	.85	.91	.95	1.02	1.11	1.25
PFLMRT	.52	.57	.60	.64	.67	.70	.74	.78	.86
PFNMRT	.54	.60	.64	.68	.72	.76	.80	.85	.93
SATACRTC	.48	.51	.54	.56	.59	.62	.65	.68	.72
SATADRTC	.43	.46	.48	.50	.53	.55	.59	.63	.68
SATDIRTC	.59	.64	.68	.71	.75	.78	.84	.90	1.04
SATINRTC	.53	.57	.61	.64	.67	.70	.74	.79	.86
VSCRTC	1.42	1.55	1.66	1.76	1.86	1.94	2.07	2.20	2.41

Table 21. Female Percentile Equivalence Scores for CogScreen Accuracy Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
ASCACC	.80	.90	.90	.90	1.00	1.00	1.00	1.00	1.00
BDSACC	.62	.75	.87	.87	.87	1.00	1.00	1.00	1.00
DATSCACC	.83	.89	.92	.93	1.00	1.00	1.00	1.00	1.00
DTTPAACC	.89	.92	.94	.95	.97	.98	1.00	1.00	1.00
DTTPDACC	.75	.82	.86	.89	.91	.93	.94	.97	.98
MANACC	.80	.90	.95	.95	1.00	1.00	1.00	1.00	1.00
MATHACC	.60	.60	.80	.80	.80	1.00	1.00	1.00	1.00
MTSACC	.90	.90	.95	.95	.95	1.00	1.00	1.00	1.00
PFCACC	.92	.96	.96	1.00	1.00	1.00	1.00	1.00	1.00
PFLACC	.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PFNACC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATACACC	.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATADACC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATINACC	.94	.97	.97	.97	1.00	1.00	1.00	1.00	1.00
SDCACC	.98	.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SDCIRACC	.00	.17	1.00	1.00	1.00	1.00	1.00	1.00	1.00
VSCACC	.95	.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 22. Female Percentile Equivalence Scores for CogScreen Throughput Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
ASCPUT	61.21	71.00	78.00	85.00	91.00	96.00	104.00	113.00	127.00
DATASCPUT	20.00	23.00	26.00	28.00	30.00	32.00	34.00	36.00	39.00
DTTPAPUT	97.00	117.00	132.00	146.00	159.00	172.00	184.00	199.00	224.00
DTTPDPUT	54.74	72.00	86.00	95.55	103.00	113.00	123.00	138.00	162.00
MANPUT	22.92	27.00	29.85	32.00	35.00	37.00	39.00	42.00	46.00
MATHPUT	1.10	1.50	1.70	1.90	2.10	2.30	2.50	2.80	3.20
MTSPUT	38.00	42.00	45.00	48.00	50.00	52.00	55.00	58.00	63.00
PFCPUT	46.00	53.00	57.00	61.00	65.00	69.00	74.00	80.00	88.00
PFLPUT	70.00	76.00	81.00	85.00	89.00	94.00	100.00	105.00	115.00
PFNPUT	63.95	71.00	75.00	79.00	83.00	88.00	94.00	100.00	110.00
SATACPUT	81.30	88.00	92.00	96.00	101.00	106.00	111.00	116.00	124.00
SATADPUT	87.81	95.00	101.00	107.00	113.00	118.00	123.00	130.00	139.00
SATDIPUT	34.00	43.62	48.68	52.32	57.00	60.00	63.00	68.00	74.00
SATINPUT	67.00	74.00	78.18	83.00	87.00	91.00	96.00	103.00	110.00
SDCPUT	68.80	76.00	81.00	85.00	89.59	93.00	97.92	102.99	111.99
VSCPUT	24.91	27.00	28.18	30.85	32.00	34.00	36.00	38.00	42.00

Table 23. Female Percentile Equivalence Scores for CogScreen Process Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
DATDPRE	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	4.00
DATIPRE	2.00	2.00	3.00	4.00	4.00	5.00	6.00	7.00	9.00
DTTAHIT	0.00	0.00	1.00	1.00	1.00	1.00	2.00	2.00	4.00
DTTDHIT	0.00	1.00	1.00	2.00	2.00	3.00	4.00	5.00	7.00
PFCCOOR	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.20	1.50
PFLCOOR	0.60	0.70	0.80	0.90	1.00	1.00	1.10	1.30	1.50
PFNCOOR	0.40	0.50	0.60	0.70	0.80	0.80	1.00	1.10	1.40
SATDIFAI	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	5.00
SATDINON	0.00	0.00	1.00	1.00	1.00	1.00	2.00	3.00	5.00
SATDIPER	0.00	1.00	1.00	1.00	2.00	2.00	3.00	3.00	5.00
SATDIRUL	4.00	6.00	7.00	8.00	8.00	8.00	8.00	9.00	9.00

Table 24. Combined Percentile Equivalence Scores for CogScreen Speed Variables

Variable	90%	80%	70%	60%	50%	40%	30%	20%	10%
ASCRTC	.47	.52	.56	.60	.64	.68	.74	.80	.91
DATDRTC	.37	.42	.46	.50	.54	.59	.64	.70	.80
DATIRTC	.26	.28	.30	.31	.33	.34	.36	.39	.44
DATSCRTC	1.48	1.60	1.70	1.81	1.92	2.05	2.22	2.48	2.88
DTTAABS	2.67	3.44	4.27	5.30	6.96	9.71	14.19	20.04	29.44
DTTDABS	10.14	13.45	17.40	22.67	30.03	40.13	50.76	62.92	77.83
DTTPARTC	.26	.29	.31	.34	.37	.41	.46	.52	.61
DTTPDRTC	.30	.36	.40	.43	.47	.52	.56	.63	.74
MANRTC	1.24	1.36	1.46	1.54	1.64	1.73	1.85	2.00	2.21
MATHRTC	15.63	17.81	19.60	21.37	23.08	24.99	27.17	30.04	34.49
MTSRTC	.91	.98	1.04	1.10	1.15	1.21	1.28	1.37	1.51
PFCMRT	.72	.79	.85	.91	.98	1.04	1.12	1.22	1.38
PFLMRT	.53	.58	.62	.66	.69	.72	.77	.82	.90
PFNMRT	.56	.61	.65	.69	.73	.78	.82	.89	.98
SATACRTC	.49	.52	.55	.57	.60	.62	.65	.68	.74
SATADRTC	.44	.47	.49	.51	.54	.57	.60	.64	.70
SATDIRTC	.60	.65	.69	.73	.76	.80	.85	.92	1.03
SATINRTC	.54	.58	.62	.65	.68	.71	.75	.80	.87
VSCRTC	1.48	1.63	1.74	1.85	1.95	2.06	2.19	2.34	2.59

Table 25. Combined Percentile Equivalence Scores for CogScreen Accuracy Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
ASCACC	.80	.89	.90	.90	.90	1.00	1.00	1.00	1.00
BDSACC	.62	.75	.87	.87	.87	1.00	1.00	1.00	1.00
DATSCACC	.82	.88	.92	.93	.94	1.00	1.00	1.00	1.00
DTTPAACC	.88	.92	.94	.95	.97	.98	1.00	1.00	1.00
DTTPDACC	.79	.86	.89	.91	.93	.94	.96	.97	1.00
MANACC	.85	.90	.94	.95	1.00	1.00	1.00	1.00	1.00
MATHACC	.60	.60	.80	.80	.80	1.00	1.00	1.00	1.00
MTSACC	.90	.90	.95	.95	.95	1.00	1.00	1.00	1.00
PFCACC	.92	.96	.96	1.00	1.00	1.00	1.00	1.00	1.00
PFLACC	.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PFNACC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATACACC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATADACC	.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATINACC	.94	.96	.97	1.00	1.00	1.00	1.00	1.00	1.00
SDCACC	.98	.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SDCIRACC	.00	.50	.83	1.00	1.00	1.00	1.00	1.00	1.00
VSCACC	.95	.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 26. Combined Percentile Equivalence Scores for CogScreen Throughput Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
ASCPUT	59.00	68.00	75.00	82.00	88.00	94.00	101.00	109.00	121.00
DATASCPUT	19.00	22.23	25.00	27.00	29.00	31.00	33.00	35.00	38.00
DTTPAPUT	91.00	109.00	124.00	139.00	154.00	169.00	183.00	201.00	227.00
DTTPDPUT	65.00	82.00	94.00	105.00	116.00	127.00	140.00	157.00	186.00
MANPUT	23.72	27.00	30.00	33.00	35.00	37.00	40.00	43.00	47.00
MATHPUT	1.20	1.50	1.80	2.00	2.20	2.40	2.70	3.00	3.50
MTSPUT	38.00	42.00	45.00	47.00	50.00	52.00	55.00	59.00	64.00
PFCPUT	42.00	48.00	52.02	57.00	61.00	65.00	69.00	75.00	83.00
PFLPUT	66.23	73.00	78.00	82.00	86.95	91.00	96.00	103.00	112.00
PFNPUT	61.00	67.41	73.00	77.00	82.00	86.00	92.00	98.00	108.00
SATACPUT	80.00	86.95	91.00	96.00	100.00	104.00	109.00	114.00	122.00
SATADPUT	84.35	93.00	98.36	104.00	110.00	115.00	121.00	128.00	136.00
SATDIPUT	32.59	42.00	48.00	52.00	55.07	59.00	63.00	67.00	74.00
SATINPUT	66.42	73.00	77.26	82.00	86.00	90.00	95.00	101.00	109.00
SDCPUT	62.71	71.99	76.00	81.00	84.99	88.20	92.99	97.02	107.90
VSCPUT	23.00	25.00	27.00	29.00	30.00	32.00	34.00	36.00	40.00

Table 27. Combined Percentile Equivalence Scores for CogScreen Process Variables

Variable	10%	20%	30%	40%	50%	60%	70%	80%	90%
DATDPRE	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	4.00
DATIPRE	2.00	2.00	3.00	4.00	4.00	5.00	6.00	7.00	9.00
DTTAHIT	0.00	0.00	1.00	1.00	1.00	1.00	2.00	2.00	4.00
DTTDHIT	0.00	1.00	1.00	2.00	2.00	3.00	4.00	5.00	7.00
PFCCOOR	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.20	1.50
PFLCOOR	0.60	0.70	0.80	0.80	0.90	1.00	1.10	1.30	1.60
PFNCOOR	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.50
SATDIFAI	1.00	1.00	1.00	2.00	2.00	2.00	3.00	3.00	5.00
SATDINON	0.00	0.00	1.00	1.00	1.00	2.00	2.00	3.00	5.00
SATDIPER	0.00	1.00	1.00	1.00	2.00	2.00	3.00	3.00	5.00
SATDIRUL	4.00	6.00	7.00	8.00	8.00	8.00	9.00	9.00	9.00

6.0 CASE EXAMPLES

6.1 Case 1

A 32-yr-old, male C-130 pilot is referred for a neuropsychological assessment following a car accident. The pilot was driving home after a Reserve weekend. It was Sunday night, and the pilot's car was hit on the passenger's side after the other driver ran a red light. The pilot was found unconscious at the scene but was breathing well, and there was no sign of cardiac, pulmonary, or vascular problems. It was likely that the pilot hit his head on the door of his car

and suffered a concussion that resulted in the loss of consciousness. As he was being placed in the ambulance, he regained consciousness.

The patient is placed on duties not including flying status by the flight surgeon pending cognitive evaluation. The patient is referred to a neuropsychiatry service, where the neurologist and neuropsychologist evaluate the patient.

The neuropsychologist administers a standard clinical intake interview along with military- and flight-specific questioning. A mental status examination is also done. For testing, the MAB is administered along with more traditional neuropsychological tests.

The patient gains an FSIQ score of 114. The VIQ is 124, and the PIQ is 104. These scores, when viewed in terms of percent level against the norms provided in Table 3, indicate the FSIQ is at the 22nd percentile, the VIQ is at the 72nd percentile, and the PIQ is at the 4th percentile.

A clinical interpretation of these scores might conclude that the FSIQ is "not bad" and "within normal limits." The VIQ is above average. The concern is the relatively low PIQ at a 4% level. This is statistically unlikely to be the patient's preaccident level of functioning. This is especially the case given the high VIQ. Further, that level of "performance" functioning calls into questioning the pilot's ability to fly whether there had been an accident or not. It is recommended that the pilot be reassigned to nonflying duties and reevaluated, if he should so desire, in 3 yr.

6.2 Case 2

A 40-yr-old, male C-17 pilot is referred following a possible carbon monoxide poisoning incident during an elk hunting trip. He and several others were in a large military-style tent being heated by a wood stove. The flue was poorly installed, and a large snowfall compounded ventilation issues. Three of the four hunters woke up in the morning complaining of headaches. Further, the pilot, upon wakening, appeared to be "confused" to the others. The symptoms were severe enough to cause the party to return home early.

The pilot reports to the flight surgeon to be "checked out." Upon questioning, the pilot primarily reports a mild difficulty paying attention. No significant physical or blood workup findings are seen. The pilot is referred to the base psychologist for further evaluation.

The pilot reports to the psychologist that since the referral some 2 wk ago, the attention difficulty has abated and no other symptoms have arisen. The psychologist administers the CogScreen along with a standard clinical interview and other tests. Interestingly, most of the Reaction Time measures are in or near the top 10% of the norm sample (as seen in Table 16). For example, the Math time was 16.0 s, placing his performance in the top 10%. Further, the Matching-to-Sample reaction time was 0.95 s, which equates to a 15%.

The interpretation is made that these scores are not just "within normal limits" but actually quite above that level. As such, it is doubtful that this pilot has had a permanent cognitive injury due to the carbon monoxide event. It is recommended that he be returned to flight status.

7.0 DISCUSSION

Clinical methods for the neuropsychological assessment of pilots without premorbid cognitive testing have been delineated. These methods focus on the comparison of an individual pilot's test data to a reference group. The very large numbers of subjects used to develop the reference norm tables suggest that clinicians can be more confident in this aspect of the evaluation.

Appendices A through C provide profile forms for the clinician to use with individual patients. For each of the three tests, profile forms are provided for male, female, and combined norms. Please note that while it is clinical custom in personality testing to use profile forms with "T-score" metrics and conversion, there is less consistency in the presentation of cognitive data by clinicians. As such, the profile forms convert individual test scores to percentiles. Percentiles are more intuitive in interpretation than T-scores. This percentile presentation allows the clinician to share data with patients and other professionals in a more straightforward manner.

A number of caveats must be mentioned. First, these data are from pilot candidates. As such, there is some chance that the data are not as precise as they might be when used for mid-career pilots. This could be due to age or attrition issues. At least with regard to attrition, Retzlaff, King, and Callister (Ref 25) found no differences in intelligence between those leaving the service after their initial commitment and those staying on.

The CogScreen and MicroCog are less well known, and larger differences may operate. This is especially true with very fast reaction time types of tasks that may have more aging effect than broader tasks.

Finally, it is important to note that this is a relatively unique approach to neuropsychology afforded by the USAF medical base-lining requirements. Psychology has a long history of neuropsychological tests, assessment, and methods. Traditional neuropsychological assessment includes many tests administered over many hours of individualized testing. It is fully expected that the current work will be in addition to, not in place of, the traditional techniques.

Interested readers are referred to the companion volume of this technical report, *Compilation of Pilot Personality Norms* (Ref 26).

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APPENDIX A

MAB Percentile Profile Forms

Percentile Profile Form for Males
Name:_____ Age:_____ Profile Sheet: MALE

	Information	Comprehension	Arithmetic	Similarities	Vocabulary		Digit Symbol	Picture Completion	Spatial	Picture Arrangement	Object Assembly		Verbal IQ	Performance IQ	Full Scale IQ	
90%	73	64	68	65	68		73	67	69	62	66		127	129	128	90%
80%	71	63	66	64	65		71	64	66	59	65		124	126	126	80%
70%	70	61	64	62	63		70	63	64	56	63		122	124	124	70%
60%	68	60	63	61	61		68	61	62	53	62		121	122	122	60%
50%	67	59	61	60	60		67	59	60	51	61		119	120	121	50%
40%	65	58	59	59	57		65	58	59	50	60		117	118	119	40%
30%	64	57	57	58	55		62	56	57	48	58		116	115	117	30%
20%	62	55	55	56	54		60	54	55	46	56		114	112	115	20%
10%	58	53	53	54	50		56	52	52	43	53		110	108	112	10%

Percentile Profile Form for Females
Name:_____ Age:_____ Profile Sheet: FEMALE

	Information	Comprehension	Arithmetic	Similarities	Vocabulary		Digit Symbol	Picture Completion	Spatial	Picture Arrangement	Object Assembly		Verbal IQ	Performance IQ	Full Scale IQ	
90%	73	63	66	65	68		73	64	66	59	66		126	126	127	90%
80%	71	62	63	64	65		72	61	63	56	64		123	123	124	80%
70%	70	61	61	62	63		71	59	61	54	63		121	121	122	70%
60%	68	60	60	61	61		70	58	59	53	61		119	119	120	60%
50%	67	59	58	60	59		68	56	58	51	60		117	117	119	50%
40%	65	58	57	59	57		67	55	56	50	59		116	115	117	40%
30%	64	56	55	58	56		65	53	54	47	58		114	113	115	30%
20%	62	55	53	56	54		62	51	52	44	56		112	110	113	20%
10%	58	53	50	55	50		58	48	48	41	52		110	106	110	10%

Percentile Profile Form for Combined Males and Females
Name:_____ Age:_____ Profile Sheet: COMBINED

	Information	Comprehension	Arithmetic	Similarities	Vocabulary		Digit Symbol	Picture Completion	Spatial	Picture Arrangement	Object Assembly		Verbal IQ	Performance IQ	Full Scale IQ	
90%	73	64	68	65	68		73	67	68	60	66		127	129	128	90%
80%	71	63	66	64	65		71	64	66	58	64		124	126	126	80%
70%	70	61	64	62	63		70	63	63	55	63		122	123	124	70%
60%	68	60	63	61	61		68	61	61	53	62		121	121	122	60%
50%	67	59	61	60	60		67	59	60	51	61		119	119	121	50%
40%	65	58	59	59	57		65	58	58	50	60		117	117	119	40%
30%	64	57	57	58	55		63	56	57	48	58		115	115	117	30%
20%	62	55	55	56	54		60	54	55	46	56		113	112	115	20%
10%	58	53	53	54	50		56	51	52	43	53		110	108	112	10%

APPENDIX B

MicroCog Percentile Profile Forms

Percentile Profile Form for Males
Name:_____ Age:_____ Profile Sheet: MALE

	Attention/ Mental Control	Memory	Reasoning/ Calculation	Spatial Processing	Reaction Time		Information Processing: Speed	Information Processing: Accuracy		General Cognitive: Functioning	General Cognitive: Processing	
90%	117	127	113	117	112		119	115		131	117	90%
80%	112	122	107	115	108		116	110		124	113	80%
70%	109	118	104	113	104		112	106		119	109	70%
60%	106	115	101	111	102		109	103		114	107	60%
50%	104	112	97	109	100		106	100		110	104	50%
40%	101	108	95	107	97		103	96		106	102	40%
30%	97	104	91	103	93		99	93		102	99	30%
20%	92	99	86	100	89		95	88		97	96	20%
10%	87	92	80	93	82		88	81		90	91	10%

Percentile Profile Form for Females
Name:_____ Age:_____ Profile Sheet: FEMALE

	Attention/ Mental Control	Memory	Reasoning/ Calculation	Spatial Processing	Reaction Time		Information Processing: Speed	Information Processing: Accuracy		General Cognitive: Functioning	General Cognitive: Processing	
90%	117	128	112	116	108		119	115		130	116	90%
80%	112	124	106	114	103		115	111		124	113	80%
70%	109	121	103	111	100		112	107		118	109	70%
60%	107	118	99	109	97		109	104		114	107	60%
50%	105	115	96	107	94		106	101		110	104	50%
40%	102	111	94	104	90		103	98		106	102	40%
30%	99	106	90	102	87		100	94		103	99	30%
20%	93	102	85	97	82		95	90		98	96	20%
10%	88	95	78	89	75		88	82		92	91	10%

Percentile Profile Form for Combined Males and Females
Name:_____ Age:_____ Profile Sheet: COMBINED

	Attention/ Mental Control	Memory	Reasoning/ Calculation	Spatial Processing	Reaction Time		Information Processing: Speed	Information Processing: Accuracy		General Cognitive: Functioning	General Cognitive: Processing	
90%	117	127	113	117	111		119	115		131	117	90%
80%	112	122	107	115	107		115	110		124	113	80%
70%	109	118	104	113	105		112	106		118	109	70%
60%	106	115	101	111	102		109	103		114	107	60%
50%	104	112	98	109	99		106	100		110	104	50%
40%	101	108	95	107	96		103	97		106	102	40%
30%	98	104	91	103	93		99	93		102	99	30%
20%	92	99	86	99	88		95	88		97	96	20%
10%	87	92	79	92	81		88	81		90	91	10%

APPENDIX C

CogScreen Percentile Profile Forms

Percentile Profile Form for Males
Name:_____ Age:_____ Profile Sheet: MALE

	ASCPUT	DATSCPUT	DTTPAPUT	DTTPDPUT	MANPUT	MATHPUT	MTSPUT	PFCPUT	PFLPUT	PFNPUT	SATACPUT	SATADPUT	PATDIPUT	SATINPUT	SDCPUT	VSCPUT	
90%	120	38	227	188	47	3.6	64	82	112	107	122	136	74	109	107	40	90%
80%	109	35	201	159	43	3.1	59	74	102	98	114	127	67	101	97	36	80%
70%	101	33	183	141	40	2.7	55	69	96	92	108	121	63	95	91	34	70%
60%	93	31	169	128	37	2.4	52	64	91	86	104	115	59	90	88	32	60%
50%	87	29	154	117	35	2.2	50	60	86	82	100	109	55	85	84	30	50%
40%	81	27	138	106	33	2.0	47	56	82	77	96	104	52	82	81	29	40%
30%	75	25	123	95	30	1.8	45	52	78	72	91	98	48	77	76	27	30%
20%	68	22	108	83	27	1.5	42	48	72	67	87	92	42	73	71	25	20%
10%	59	19	91	66	24	1.2	38	42	66	61	80	84	32	66	62	23	10%

Percentile Profile Form for Females
Name:_____ Age:_____ Profile Sheet: FEMALE

	ASCPUT	DATSCPUT	DTTPAPUT	DTTPDPUT	MANPUT	MATHPUT	MTSPUT	PFCPUT	PFLPUT	PFNPUT	SATACPUT	SATADPUT	PATDIPUT	SATINPUT	SDCPUT	VSCPUT	
90%	127	39	224	162	46	3.2	63	88	115	110	124	139	74	110	112	42	90%
80%	113	36	199	138	42	2.8	58	80	105	100	116	130	68	103	103	38	80%
70%	104	34	184	123	39	2.5	55	74	100	94	111	123	63	96	98	36	70%
60%	96	32	172	113	37	2.3	52	69	94	88	106	118	60	91	93	34	60%
50%	91	30	159	103	35	2.1	50	65	89	83	101	113	57	87	90	32	50%
40%	85	28	146	96	32	1.9	48	61	85	79	96	107	52	83	85	31	40%
30%	78	26	132	86	30	1.7	45	57	81	75	92	101	49	78	81	28	30%
20%	71	23	117	72	27	1.5	42	53	76	71	88	95	44	74	76	27	20%
10%	61	20	97	55	23	1.1	38	46	70	64	81	88	34	67	69	25	10%

Percentile Profile Form for Combined Males and Females
Name:_____ Age:_____ Profile Sheet: COMBINED

	ASCPUT	DATSCPUT	DTTPAPUT	DTTPDPUT	MANPUT	MATHPUT	MTSPUT	PFCPUT	PFLPUT	PFNPUT	SATACPUT	SATADPUT	PATDIPUT	SATINPUT	SDCPUT	VSCPUT	
90%	121	38	227	186	47	3.5	64	83	112	108	122	136	74	109	108	40	90%
80%	109	35	201	157	43	3.0	59	75	103	98	114	128	67	101	97	36	80%
70%	101	33	183	140	40	2.7	55	69	96	92	109	121	63	95	93	34	70%
60%	94	31	169	127	37	2.4	52	65	91	86	104	115	59	90	88	32	60%
50%	88	29	154	116	35	2.2	50	61	87	82	100	110	55	86	85	30	50%
40%	82	27	139	105	33	2.0	47	57	82	77	96	104	52	82	81	29	40%
30%	75	25	124	94	30	1.8	45	52	78	73	91	98	48	77	76	27	30%
20%	68	22	109	82	27	1.5	42	48	73	67	87	93	42	73	72	25	20%
10%	59	19	91	65	24	1.2	38	42	66	61	80	84	33	66	63	23	10%

LIST OF ABBREVIATIONS AND ACRONYMS

AE	aeromedical edition
AFOQT	Air Force Officer Qualifying Test
ASC	Auditory Sequence Comparison
BDS	Backward Digit Span
DAT	Divided Attention
DTT	Dual Task
FSIQ	full-scale intelligence quotient
MAB	Multidimensional Aptitude Battery
MAN	Manikin
MATH	Math
MFS	Medical Flight Screening
MTS	Matching-to-Sample
PF	Pathfinder
PIQ	performance intelligence quotient
SAT	Shifting Attention
SD	standard deviation
SDC	Symbol Digit Coding
SUPT	Specialized Undergraduate Pilot Training
USAF	United States Air Force
VIQ	verbal intelligence quotient
VSC	Visual Sequence Comparison
WAIS	Wechsler Adult Intelligence Scales